University of Southern Queensland

Quantifying the Properties of a Dosimeter Responsive to Blue Light Hazard Effective Wavelengths

A dissertation submitted by

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For the award of

Master of Science (Research)

2014

ACKNOWLEDGEMENTS

I would like to express my special thanks of gratitude to my supervisor Professor Alfio Parisi, who gave me the golden opportunity to do this wonderful project on the topic "Quantifying the Properties of a Dosimeter Responsive to Blue Light Hazard Effective Wavelengths", which also helped me in doing a lot of research and I came to know about so many new things. I am really thankful to my husband and my kids who have supported me a lot to finalize this work within the time. I would also like to thank my family and friends who have always paid attention about what I did in my project, and morally help has also been given. I would like to thank the Physical Sciences staff of the University of Southern Queensland for their support over the course of this program. Finally, I am doing this project not only for marks but to also increase my knowledge.

Certification of Dissertation

I certify that the ideas, experimental work, results, analyses, software and conclusions reported in this dissertation are my own effort, except where otherwise acknowledged. I also certify that work is original and has not been previously submitted for any other award, except where otherwise acknowledged.

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ENDORSEMENT

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Signature of Supervisor Date

ABSTRACT

The research reported in this dissertation characterizes the properties of a proposed blue light dosimeter suitable for measuring the ocular blue light hazard. Blue light of high intensity with shorter wavelengths (400-500 nm) has been shown to produce an adverse effect on the healthy human eye, and the hypothesis proposed is that a dosimeter based on polysulphone and phenothiazine has the properties to act as a dosimeter to measure exposure to the blue light hazard. Exposure to the shorter wavelengths of blue light is measured by weighting the spectral irradiance of a light source against the blue light hazard action spectrum, and the dosimeter employed in this study uses a long pass filter to remove ultraviolet wavelengths shorter than 380 nm. An examination of the polysulphone and phenothiazine dosimeters was completed for the change in absorbance, dose response, the dark reaction, repeatability of measurement, the influence of the angle of the receiving plane, and stability against changes in irradiation and temperature. The results show that a change in the dosimeter optical transmission occurs as a result of exposure to blue light, with maximum dosimeter response after exposure to wavelengths around 420 nm. The polysulphone and phenothiazine dosimeters were exposed to four light sources and dose response calibration curves established that relate blue light exposure to the change in absorbance. The effect of the angle of the receiving plane was found to be approximated by a cosine function for angles up to 70º from the normal, with the difference between measured and theoretical values in this angle range being less than about 0.2. Dosimeter response to repeated solar radiation exposure was found to be reproducible with a standard error in the ΔA of 0.005. The dark reaction of the dosimeter

in terms of the average change in absorbance in darkness was also found to be small, with a change of 0.056 at zero hours being 0.058 after 24 hours and 0.067 after one week. Dosimeter rate variations with irradiance variations between 10 W/m^2 and 15 W/m^2 were found to be only ± 10 %, and thus within the measurement error of the badges. Dosimeter responses were also found to be stable for temperatures ranging from 23 ºC to 37 ºC. Taken together, all these results lead to the conclusion that polysulphone and phenothiazine dosimeters have characteristics that enable their widespread use for rapid, convenient and low-cost assessment of the blue light hazard.

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